National Spent Nuclear Fuel Program

Advanced Nondestructive Assay

Mission
Develop a nondestructive Assay system to characterize fissile and other radioactive material without disturbing the container

Benefits
- Reduce worker exposure to radiation
- Measure fuel properties independently
- Reduce assay cost
- Provide qualified data for transportation, storage, or disposal of material
- Validate existing data
- Provide qualified data to reduce process conservatism costs
- Reduce safety and security risk concerns
- Detect special nuclear material in weapons configurations

Current Issues
Large and complex system needs refinement

Project Status
Performing proof of concept

MDAS Collaborators
- Argonne National Laboratory-West (ANL-W)
- Intense Pulsed Neutron Source Facility (IPNS)
- Oak Ridge Electron Linear Accelerator (ORELA)
- Vanderbilt University

Purpose
A nondestructive assay (NDA) technology called the Multi-Detector Analysis System (MDAS) is being prototyped at the Idaho National Engineering and Environmental Laboratory (INEEL) to characterize spent nuclear fuel. The U.S. Department of Energy (DOE) manages more than 250 types of spent nuclear fuel. This fuel often lacks complete and adequate characterization documentation necessary for its transport and disposal in a national repository.

A green shipping cask is lowered into a shield ring. Large arrays of germanim and xylene detectors collect signals from neutrons that are directed at the material.

Project Description
The MDAS technology provides a means to collect fissile material inventory information about spent nuclear fuel and remote-handled transuranic waste. It will perform characterization without disturbing sealed containers and without the need for process knowledge and historical records. This technology integrates the fundamental physics of fission and decay processes, large detector arrays, very fast coincidence methods, high-speed data acquisition, real-time analysis, and archival mass data storage methods. When fully developed, MDAS will measure:

- Total fissile mass used for input into criticality and safety calculations
- Fissile isotopes; specifically uranium enrichment and transuranics
- Specific fission products including isotopes with gamma-ray coincidence relationships that can be used in models to generate detailed radionuclide inventories
- Radiological source term data used for providing shielding and safety guidelines.

The INEEL project team is conducting the MDAS research with support from other collaborators.

INEEL
Idaho National Engineering & Environmental Laboratory
BECHTEL BWXT IDAHO, LLC

Benefits

MDAS is being developed to provide qualified characterization data that support transport, storage, or permanent disposal into a national repository. It has the potential to validate existing unqualified characterization data.

This technology is designed to independently verify characterization data that is based on records and computation. An example of this type of verification is burnup credit, which is the net reduction of fissile material and the buildup of neutron absorbers in the fuel as it is irradiated. Data obtained through MDAS could result in higher burnup allowances and reduce process conservatism and packaging costs. Refueling schedules and canister loading may become more cost-effective using this technology. Accurate NDA measurements will minimize worker radiological exposure and reduce costs that would otherwise be incurred through other analytical processes. (MDAS may also provide information on the presence and location of special nuclear materials in weapons configurations.)

Unique Capabilities

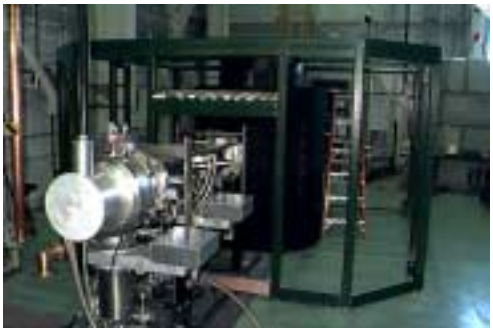
Significant advances in computer speed and the ability to collect and process large amounts of data are making MDAS possible. In addition, fundamental research on fission is producing information unknown prior to the experiments, and this information is being applied for the first time. Another unique aspect of MDAS is that the system does not require calibration standards or previous characterization data on a specific fuel element or transuranic waste package to perform its analysis.

Current Issues

MDAS is a very large and complex system. To overcome the complexity of the technology, the project team is developing analytical and graphical user interface codes. This code development supports system refinement. The project team is also optimizing the design, modifying, and refining MDAS to meet customer needs.

Project Status

MDAS is currently a research and development project. The project team completed the installation and acceptability/operability tests of the neutron generator. The project team will use the results of this testing to improve the performance of the system, aid in design modifications, improve operational methods, and provide proof of concept.



A neutron generator is the external source of neutrons for inducing fissions. Data from the fissions provide the ratio of fissile isotopes and the total quantity of fissile material. The framework behind the generator supports the primary shielding that surrounds the radioactive item being examined.

MDAS uses high-speed data acquisition methods and distributed analysis of data. The list-mode data storage method stores data and passes it to other computers for analysis. All gamma-ray energies, the number of neutrons, and the time relationships between them are stored for each fission event.

1988-1993

Fission Assay Tomography System (FATS) and Gamma-Neutron Analysis System (GNATS) developed

1997

Purchased detectors and supporting equipment

1998

Moved MDAS to Argonne National Laboratory-West to access spent nuclear fuel

Procured shield ring

Applied for patent

1999

Initiated procurement of neutron generator

Neutron generator received

2000

Neutron generator installed

Acceptance test

Measure spent nuclear fuel and transuranic waste surrogate

Issue report on results of measurement

2001

Measurements to confirm system capabilities

Evaluate system modifications

Develop analytical software

Project Contacts

Kathleen A. Asbell
Phone: (208) 526-8330
Fax: (208) 526-5337
E-mail: kia@inel.gov

Jerald D. Cole
Phone: (208)533-7553
Fax: (208) 533-7927
E-mail: djc@inel.gov